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*Indian Standard*

# EQUIPMENT FOR CONTINUOUSLY MONITORING RADIOACTIVITY IN GASEOUS EFFLUENTS

## PART 2 SPECIFIC REQUIREMENTS FOR AEROSOL EFFLUENT MONITORS

भारतीय मानक

# गैसीय बहिस्रावों में अपक्रांतिकता लगातार मानीटर करने के लिए भारतीय मानक उपस्कर

## भाग 2 एयरोसोल बहिस्राव मानीटरों की विशिष्ट अपेक्षाएँ

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# EQUIPMENT FOR CONTINUOUSLY MONITORING RADIOACTIVITY IN GASEOUS EFFLUENTS

## PART 2 SPECIFIC REQUIREMENTS FOR AEROSOL EFFLUENT MONITORS

### NATIONAL FOREWORD

This Indian Standard ( Part 2) which is identical with IEC Pub 761-2 (1983) 'Equipment for continuously monitoring radioactivity in gaseous effluents: Part 2 Specific requirements for aerosol effluent monitors', issued by the International Electrotechnical Commission (IEC), was adopted by the Bureau of Indian Standards on 25 August 1989 on the recommendation of the Nuclear Instrumentation Sectional Committee (LTDC 26) and approval of the Electronics and Telecommunication Division. Council.

Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.

### CROSS REFERENCES

In this Indian Standard, the following International Standards are referred to; Read in their respective places the following:

| *International Standard* | *Corresponding Indian Standard* | *Degree of Correspondence* |
|---|---|---|
| IEC Pub 50 International electro-technical vocabulary | IS 1885 (Part 63) : 1985 Electro-technical vocabulary: Part 63 Nuclear instrumentation | Technically equivalent |
| IEC Pub 761-l (1983) Equipment for continuously monitoring radio-activity in gaseous effluents : Part I General requirements | IS 12761 (Part 1) : 1989 Equipment for continuously monitoring radio-activity in gaseous effluents: Part 1 General requirements | Identical |

Only the English language text of the International Standard has been retained while adopting it in this Indian Standard.

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# CHAPTER I: GENERAL

## 1. Scope

This standard is applicable to equipment intended for continuous monitoring of aerosols in gaseous effluents discharged in the environment.

It is applicable to equipment designed to fulfil the following functions:

- — the measurement of the concentration of radioactivity emitted in gaseous effluents in the form of aerosols, either per unit time together with the variations as a function of time, or integrated over a longer time period, for example 24 h;
- — the actuation of an alarm signal when either a predetermined high concentration or a predetermined time integrated concentration of an aerosol activity is exceeded.

In order to improve the precision and sensitivity of the measurements, complementary laboratory analyses of the filters after collection may be performed.

Electrostatic precipitator and impactor equipments are not considered in this standard.

Effluent aerosol monitors designed for monitoring alpha emetters such as transuranic elements or those which require compensation for natural alpha activity will be considered in detail in a future publication.

Effluent aerosol monitors designed for selective monitoring (for instance plutonium aerosol contamination), are not considered in this standard.

## 2. Object

The object of this standard is to lay down specific standard requirements, including technical characteristics and general test conditions and to give examples of acceptable methods for aerosol effluent monitors, defined in Clause 3, and equipped with filters for the retention of radioactive aerosols.

The general requirements, technical characteristics, test procedures, radiation characteristics, electrical, mechanical, safety and environmental characteristics are given in IEC Publication 761-1: Equipment for Continuously Monitoring Radioactivity in Gaseous Effluents, Part 1: General Requirements.

These requirements apply, unless otherwise stated, to this standard.

## 3. Terminology

For the purposes of this standard, the tollowing additional definitions, shall apply:

3.1 *Aerosols*

Suspension of fine solid or liquid particles, with dimensions generally in the range between 0.01 μm and a few tens of micrometres.

3.2 *Aerosol effluent monitor*

Equipment designed for the continuous monitoring of aerosol activity in gaseous effluents discharged into the environment.

3.3 *Total equivalent window thickness*

The equivalent thickness, generally expressed in mass per unit area ($mg\,cm^{-2}$), that a particle emitted normally from the surface of the aerosol collecting filter shall cross in order to reach the sensitive volume of the detector.

This thickness includes the distance covered in air plus the detector window thickness and the thickness of any thin screen over the detector for protection against radioactive contamination.

3.4 *Conventionally true emission rate*

The best estimate of the surface emission rate of a source; this value and its uncertainty shall be determined from a secondary or a primary standard, or by a reference instrument which has been calibrated against a secondary or primary standard.

## 4. Classification of aerosol effluent monitors

The equipment may be classified according to the type of radiation measured as:

— gross beta aerosol monitors;
— gross alpha aerosol monitors;
— gross alpha and gross beta aerosol monitors.

It may also be classified according to the method of operation as:

— equipment with static filter sampler and simultaneous measurement;
— equipment with moving filter sampler and simultaneous measurement;
— equipment with moving filter sampler and delayed measurement.

## CHAPTER II: AEROSOL EFFLUENT MONITOR DESIGN

### 5. Check source

A check source shall be supplied with the equipment and shall be wherever possible designed in such a way as to be placed in the aerosol retention device instead of the filter (see also Clause 13 and Clause 15 of I E C Publication 761- 1).

### 6. Expression of measurement

In accordance with the requirements of Clause 10 of I EC Publication 761-1, the electronic measuring assembly associated with the detector shall normally provide a reading expressed directly in the electrical unit measured, for example in counts per second or in amperes.

If, by agreement between manufacturer and user, the reading is expressed in units of volumetric activity or deposited activity on the collecting surface, the manufacturer shall state the calibrations and the radionuclide or nuclides for which they apply.

### 7. Ease of decontamination

As the sensitive surface of the radiation detector will normally be in contact with the gaseous medium containing the radioactive aerosols, special care shall be taken in the design to facilitate, decontamination of the detector head. Wherever possible, the detector head shall be protected by applying a thin screen that is easily exchangeable in front of the detector window.

### 8. Sampling and detection assembly

#### *8.1 Sampling and exhaust pipes*

In addition to the general requirements of I EC Publication 761-1, the following characteristics shall be considered and shall be agreed between manufacturer and user:

- the nature of the materials used giving particular attention to electrostatic effects and chemical corrosion;
- the minimum distance between inlet and outlet to avoid any recirculation;
- temperature control of the pipe run in order to prevent condensation.

#### 8.2 *Air (or gas) pump*

In addition to the requirement of Clause 29 of I EC Publication 761-1, the air or gas pump shall be capable of withstanding the variation of pressure induced by normal operating conditions (maximum expected sampling time, usable filter types, atmospheric dust mass concentration contributing to blockage, etc.), so that there shall not bc at the end of sampling. a reduction from nominal air flow rate of more than 20% or an error in the value of total air volume sampled of more than 10%.

8.3 *Aerosol retention devices*

8.3.1 The collecting surface may have different geometries according to the method of operation of the assembly (see Clause 4):

- circular, for example, for static filter assemblies;
- square or rectangular, for example, for moving filter assemblies.

For moving filters, square or rectangular geometry allows a simplification of calibration techniques.

8.3.2 The equipment may be designed for use with a range of fibre filters (cellulose, glass, etc.) or plastic filters. The design shall be such as to facilitate decontamination of the aerosol retention devices when necessary. The recommended filter type shall be stated by the manufacturer.

8.3.3 In choosing filters for equipment detecting alpha emitting radioactive aerosols, it is preferable to use glass fibre or plastic filters because of their low self-absorption for alpha particles.

8.3.4 The homogeneity of deposition of aerosols collected on the filters is not a critical parameter, but gross non-uniformity shall be avoided.

8.3.5 The design of the aerosol retention device shall be such as to minimize deposition on the walls of the air intake.

8.3.6 The filter-holder design characteristics (dimensions, geometry, etc.), shall take account of the mechanical strength of the filters used and the characteristics of the air (or gas) sampling pump.

8.3.7 For simultaneous sampling and measuring assemblies, the measurement of aerosol volume activity may be disturbed by radioactive gases, such as $^{41}$A, $^{85}$Kr, $^{133}$Xe, etc., liable to be present in the sampled air (or gas). This shall be minimized by the special geometry of cavities located near the detector above and below the filter and the corresponding reduction of dead volumes.

8.3.8 The design shall be such as to minimize leaks, particularly internal leaks causing the flow to bypass the filter.

8.3.9 Access to the filter shall be designed in such a manner as to permit fast and easy removal without risk of damage to the detection device (e.g. automatic switching off of the high voltage in the case of a scintillation detector which is not light-tight).

8.4 *Radiation detector*

8.4.1 The manufacturer shall fully specify the detector characteristics, including the detector dimensions and the dimensions and transmission characteristics (e.g. effective area, thickness, etc.) of any protective screens. He shall also specify the variation of detection efficiency with particle energy of nuclide.

8.4.2 The useful detection surface area of the detector shall be approximately equal to that of the aerosol collecting surface.

8.4.3 The maximum total equivalent window thickness (normal to the source surface at the entrance to the useful volume of the detector) shall be chosen according to the type of radiation detected:

- alpha particles: less than 2 $\mathrm{mg \cdot cm^{-2}}$ (loss of energy equivalent to 3.2 MeV);
- beta particles: total equivalent thickness shall be appropriate to the particle energy spectrum to be detected. The manufacturer shall state the total equivalent thickness.

## 9. Response to other ionizing radiations

Equipment shall be designed so as to limit, as far as possible, the influence of ionizing radiations other than those specified.

## 10. Discrimination against natural radioactivity

### 10.1 *Methods of discrimination*

The most difficult problem in monitoring low-level radioactivity in air arises from the presence of natural airborne radionuclides such as radon and thoron and their daughters and the variation of their concentrations in air from day to day, time of the day, weather, ventilation conditions, etc.

‘There are several ways to discriminate against such influences:

- delayed measurement after suitable decay of the natural radionuclides (which are mostly of short half-life);
- spectrometric measurements (mainly used with alpha contamination meters);
- measurements related to other physical properties of the natural radionuclides, for example pseudo-coincidence measurements;
- chemical methods of separation;
- particle size selection.

### 10.2 *Requirements for electronic method of compensation*

If an electronic method of compensation against natural radioactivity is used, the manufacturer shall state:

- the adjustment procedure (which generally involves the correct determining and setting of a compensation factor);
- a suitable test method for checking the proper functioning of the compensation device;
- the effectiveness of compensation in terms of the residual counts per second per unit of natural radioactivity on the filter and of the variation of the residual pulse rate relative to the variation of the uncompensated pulse rate.

# CHAPTER- III: TEST PROCEDURES

Except where otherwise specified, tests are to be considered as type tests, although any or all may be considered as acceptance tests by agreement between manufacturer and user.

## 11. Standard test conditions

The standard test conditions are shown in Table I. These represent the values and tolerances of the various influence quantities for tests carried out with no variation of these values.

The tests carried out under standard test conditions are listed in Table II.

## 12. Tests performed with variation of the influence quantities

These tests are listed in Tables III and IV. They shall be carried out in accordance with Clause 24 of I E C Publication 76 1- 1.

## 13. Reference and special sources

For the purpose of testing this equipment, all sources of activity are defined in terms of surface emission rate, in order to avoid the problem of establishing the self-absorption factor for sources quoted in terms of activity.

When calibrating the equipment, the actual self-absorption factor for activity deposited in the filter shall be established.

### 13.1 *Reference sources*

For any tests which may be performed with only a single type of radiation, beta or alpha radiation shall be used as relevant.

The reference beta radiation shall normally be provided by a reference source of $^{204}$Tl and the reference alpha radiation provided by a reference source of $^{239}$Pu or $^{241}$Am. Alternative reference radiation sources may be used by agreement between manufacturer and user.

### 13.2 *Special sources*

The sources used for the tests with variation of beta energy are defined as special sources. By way of information, a list of some suitable radionuclides is given below:

| Radionuclide | Half-life | Maximum energy (MeV) |
|---|---|---|
| $^{63}Ni$ | 80 years | 0.067 |
| $^{14}C$ | 5.6 $10^3$ years | 0.158 |
| $^{203}Hg$ | 45.8 days | 0.210 |
| $^{147}Pm$ | 2.5 years | 0.230 |
| $^{45}Ca$ | 164 days | 0.250 |
| $^{60}Co$ | 5.3 years | 0.310 |
| $^{185}W$ | 74 days | 0.43 |
| $^{36}Cl$ | 3 $10^5$ years | 0.714 |
| $^{204}Tl$ | 3 years | 0.11 |
| $^{198}Au$ | 2.7 days | 0.96 |
| $^{89}Sr$ | 51 days | 1.46 |
| $^{32}P$ | 14.3 days | 1.71 |
| $^{90}Sr/^{90}Y$ | 28 years | 2.27 |

### **13.3** *Design of sources*

Reference and special sources shall be designed with the same effective dimensions as the area of the deposit on the filter used in a static position.

The sources shall be free from external radioactive contamination. Care must be taken to account for the gamma radiation of the calibration source.

### 13.4 Accuracy *of test sources*

The conventionally true surface emission rate of all test sources shall be known to an accuracy of ± 10% :

$$(\varepsilon_{SA} \leqslant 10\%, \ \varepsilon_{SR} \leqslant 5\%)$$

## 14. **Radiation performance tests**

These tests are carried out under standard test conditions and without air (or gas) flow with the exception of the test described in Sub-clause 14.5.

If an electronic method of compensation against natural radioactivity is included, all tests of the measuring assembly shall be performed with the compensation circuits in operation, after having been adjusted according to the instructions of the manufacturer.

### 14.1 *Accuracy of the response to reference sources*

#### 14.1.1 *Requirement*

Tests shall be carried out in accordance with Sub-clause 26.2 of I EC Publication 761-1 but to the accuracy requirements of Table II of this standard.

#### 14.1.2 *Test method*

Depending on whether the assemblies are for alpha or beta radiation, use the reference radiation referred to in Sub-clause 13.1

In order to cover the whole of the scale of the measuring assemblies, several sources of each type may be necessary. In this case, the conventionally true activity of all the sources of the same type used may be calibrated in terms of that from one particular source, which may be considered as the reference source. By this method errors other than the relative intrinsic error of the assembly under test are reduced.

The reference source shall be in a position defined by the manufacturer in place of the filter. The relative intrinsic error *E* given as a percentage shall be established for each test, in accordance with Sub-clause 26.2.5 of IEC Publication 761-1, with the conventionally true surface emission substituted for conventionally true activity.

### 14.2 *Response us a function of beta radiation energy (beta monitors)*

#### *14.2.1 Requirements*

The variation in the response of the equipment shall not exceed the limits specified by the manufacturer.

The behaviour of the equipment for energies lower than 150keV should be stated by the manufacturer on request.

A typical calibration graph showing the variation of response with beta radiation energy shall be issued with each equipment. The beta radiation energies chosen shall be stated by the manufacturer. The thickness and the nature of the materials between the filter and the sensitive volume of the detector shall be stated.

#### *14.2.2 Test method*

The tests shall be performed with at least three beta emitters, whose maximum energies are distributed as follows:

— one $\leqslant$0.4 MeV;
-- one between 0.4 MeV and 1 MeV;
— one $\geqslant$ 1 MeV.

The results shall be expressed as the ratio of the response per unit surface emission rate for each beta source used to the response per unit surface emission rate for the reference beta radiation.

For assemblies with linear scales, all the sources used shall give indications exceeding one-third of full scale deflection on the scale being use.

For assemblies with non-linear scales, all the sources used shall give indications exceeding the first decade.

### 14.3 *Response as a function of alpha raditrtion energy (alpha monitors)*

Tests with variation of alpha energy arc not required unless agreed between manufacturer and user.

However, for each equipment the manufacturer shall specify the minimum detectable alpha energy, taking into account the thickness of the window of the detector used.

### 14.4 *Cross-response to alpha and beta radiation*

#### 14.4.1 *Requirements*

When the equipment is used to measure beta or alpha activities in a mixed alpha-beta activity discharge, the measurements may be altered by the influence of the other radiation.

In each case the limit of variation of the indication is that given in Table III

**14.4.2** *Test method*

For a given equipment the response $R_{\text{ref}}$ in terms of counting rate related to the unit surface emission rate of the appropriate reference source (beta source for a beta monitor, alpha source for an alpha monitor) shall be established as:

$$R_{\text{ref}} = \frac{\text{counting rate}}{\text{surface emission rate}}$$

For the same equipment, the response to the other ionizing radiation shall be then established by using the reference source for the other radiation (alpha source for a beta monitor, beta source for an alpha monitor). The response expressed in the same units as $R_{\text{ref}}$ shall conform to:

$$R \leqslant 5 \cdot 10^{-2} R_{\text{ref}}$$

14.5 *Response to gas activity*

14.5.1 *Requirement*

The response to radioactive gases of interest present in the sample of air or carrier-gas shall be specified by the manufacturer.

14.5.2 *Test method*

Connect the inlet air duct to the outlet air duct and measure the total air duct volume (e.g. connecting the inlet air duct to a know volume under pressure and noting the pressure change on equilibrium). Inject into the system a small volume (1% of the air duct volume) of gas, for example $^{133}$Xe or $^{85}$Kr, of known total activity. Operate the aerosol meter (or monitor) in the normal way.

Note the reading corresponding to equilibrium or to the highest value attained. Express the result as the ratio of the counting rate to the volumetric activity of the test gas.

## 15. Tests of the air circuit

In addition to the tests specified in Clause 29 of IEC Publication 761-1, the following tests shall be carried out:

15.1 *Leakage*

The test measures the external leakage but not the internal leakages around the filter holder. A quantitative method of test for internal leakage is not, at this time, considered practicable.

15.1.1 *Requirement*

The leakage of air or gas into the assembly upstream of the flow metering shall bc less than 5% of the nominal flow rate.

15.1.2 *Test method*

The rate of leakage at the filter holder fitted with a clean filter shall be measured by means of two volume meters or flow meters; these shall be calibrated relative to one another to better than 1%. One apparatus shall be placed upstream of the assembly and the other downstream of the filter holder and immediately upstream of the flow meter incorporated in the assembly. For a series of ten consecutive measurements made at convenient time intervals (even after a heavy deposit) the mean of the measured upstream and downstream flows shall differ by not more than 5%.

## CHAPTER IV: DOCUMENTATION

### 16. Type test report and certificate

With each equipment, the manufacturer shall provide a certificate giving the following information in addition to that specified in Chapter IV of I EC Publication 761-1:

— size, type and orientation (flow direction) of filter medium to be used;

— equivalent thickness of the window and the screen;

— characteristics of the reference sources used;

— delay time between sampling and measurement (where sampling and measurement is not simultaneous);

— upper limit of dust deposition on the filter that can be tolerated without adverse effect on the measurement;

— radionuclides for which the equipment is designed (degree of selectivity) and the response to these nuclides as a function of the activity per unit of volume;

— response to other radionuclides if the measurement is selective;

— response to radioactive noble gases.

TABLE I

*Reference conditions and standard test conditions*

(Unless otherwise indicated by the manufacturer)

| Influence quantity | Reference conditions | Standard test conditions |
|---|---|---|
| Reference beta radiation source<br>Reference alpha radiation source<br>Warm-up time:<br>— electronic devices<br>— air or gas circuit | $^{204}$Tl<br>$^{239}$Pu or $^{241}$Am<br><br>15 min<br>60 min | $^{204}$Tl<br>$^{239}$Pu or $^{241}$Am<br><br>⩾ 15 min<br>⩾ 60 min |
| Ambient temperature | 20°C | 18°C to 22°C |
| Relative humidity | 65% | 50% to 75% |
| Atmospheric pressure | 101.3 kPa | 86 kPa to 106 kPa* |
| Power supply voltage | Nominal supply voltage $U_{\mathrm{N}}$ | $U_{\mathrm{N}} \pm 1\%$ |
| Power supply frequency | Nominal frequency | Nominal frequency ±0.5% |
| Power supply waveform | Sinusoidal | Sinusoidal with total harmonic distortion less than 5% |
| Gamma radiation background | Absorbed dose rate in air of 0.2 $\mu\mathrm{Gy \cdot h^{-1}}$ (20 $\mu\mathrm{rad \cdot h^{-1}}$) | Less than absorbed dose rate in air of 0.25 $\mu\mathrm{Gy \cdot h^{-1}}$ (25 $\mu\mathrm{rad \cdot h^{-1}}$) |
| Electromagnetic field of external origin | Negligible | Less than the lowest value that causes interference |
| Magnetic induction of external origin | Negligible | Less than twice the value of the induction due to the earth's magnetic field |
| Sampling rate | Adjusted to nominal flow-rate (defined by manufacturer) | Adjusted to nominal rate ± 5% |
| Assembly controls | Set for normal operation | Set for normal operation |
| Contamination by radioactive elements | Negligible | Negligible |

* Where the detection technique is particularly sensitive to variation in atmospheric pressure, the conditions shall be limited to ± 5% of the reference pressure.

TABLE II

### *Tests performed under standard test conditions*

| Characteristics under test | Requirements | Reference (sub-clause) | |
|---|---|---|---|
| | | IEC Publ. 761-1 | IEC Publ. 761-2 |
| Reference response | In accordance with the manufacturer's specifications | 26.i | |
| Accuracy of indication ($E_I$) | Less than ±20% or, for assemblies with linear scales, less than 5% of the activity corresponding to maximum indication on appropriate scale (whichever is least restrictive) | 26.2 | 14.1 |
| Response to radioactive noble gases | In accordance with the manufacturer's specifications | | 14.5 |
| Overload | To remain at full scale indication when exposed to an activity 10 times that which would give a full scale deflection | 26.5 | |
| Statistical fluctuations | Coefficient of variation less than 10% | 27.1 | |
| Stability of indication | Less than 10% of the full scale angular deflection over a period of 500 h on all ranges or less than 10% of indication for digital display | 27.6 | |
| Alarm trip stability | Less than 20% of set-point level over a period of 500 h | 27.7 | |
| Alarm trip range | In accordance with Clause 13 of IEC Publication 761-l | 27.8 | |
| Equipment failure alarms | Low level alarm in accordance with Clause 13 of IEC Publication 761-1, other alarms by agreement between manufacturer and user | 27.9 | |

TABLE III

*Tests performed with variation of influence quantities*

| Influence quantity | Range of values of influence quantity | Limits of variation of indication | Reference (sub-clause) | |
|---|---|---|---|---|
| | | | IEC Publ. 761-1 | IEC Publ. 761-2 |
| Beta radiation energy | From approximately 150 keV to approximately 2.5 MeV | In accordance with manufacturer's specifications | | 14.2 |
| Alpha radiation energy (if required) | As agreed by manufacturer and purchaser | In accordance with manufacturer's specifications | | 14.3 |
| Other ionizing radiation:<br>beta measuring assembly<br>alpha measuring assembly | <br>Alpha reference source of $^{239}$Pu<br>Beta reference source of $^{204}$Tl | $R \leqslant 0.05\, R_{ref}$ | | 14.4 |
| External gamma radiation from a $^{137}$Cs source in defined source/detector geometry | Absorbed dose rate in air of $10\ \mu Gy \cdot h^{-1}$ ($1\ mrad \cdot h^{-1}$) | In accordance with the manufacturer's specification | 26.4 | |
| External gamma radiation from a $^{137}$Cs source in other geometries | Absorbed dose rate in air of $10\ \mu Gy \cdot h^{-1}$ ($1\ mrad \cdot h^{-1}$) | As specified, but normally less than twice-that under reference conditions | 26.4 | |
| External gamma radiation from other sources in the defined source/detector geometry | Absorbed dose rate in air of $10\ \mu Gy \cdot h^{-1}$ ($1\ mrad \cdot h^{-1}$) | As specified but normally less than twice that under reference conditions | 26.4 | |
| Warm-up time | ⩾ 30 min | ±10%[1] | 27.2 | |
| Power supply voltage | 88% $U_N$ to 110% $U_N$ ($U_N$ = nominal supply voltage) | ± 10%[1] | 27.4 | |
| Power supply frequency | 47 Hz to 51 Hz[2] | ±10%[1] | 27.4 | |
| Power supply transient effects | In accordance with Sub-clause 27.5 of IEC Publication 761-1 | In accordance with Sub-clause 27.5 of IEC Publication 761-1 | 27.5 | |
| Ambient temperature[3] | Indoor use:<br>10 °C to 50 °C<br>Outdoor use:<br>−10 °C to 40 °C<br>−25 °C to 50 °C | <br>±10%[1]<br><br>±20%[1]<br>±50%[1] | 28.1 | |

*(Table and notes continued on page 35)*

TABLE III *(continued)*

| Influence quantity | Range of values of influence quantity | Limits of variation of indication | Reference (sub-clause) | |
|---|---|---|---|---|
| | | | IEC Publ. 761-1 | IEC Publ. 761-2 |
| Relative humidity | Up to 90% at 30 °C | ± 10%1) | 28.2 | |
| Atmospheric pressure | 4) | 4) | 28.3 | |
| Electromagnetic field of external origin | 4) | 4) | | |
| Magnetic induction of external origin | 4) | 4) | | |

1) Of the indication under standard test conditions.

2) 57 Hz to 61 Hz for the United States of America and Canada.

3) Assemblies intended for temperate climates. In hotter or colder climates other limits may be specified.

4) No general specification. Range of value of influence quantity and limits of variation of indication to be specified if required.

Note. — For assemblies having a non-linear scale, a linear instrument can be substituted for the indicating meter of the assembly to verify the performance called for by this table.

TABLE IV

### *Tests of air (or gas) circuit*

(These tests are applicable only to assemblies whose response is dependent on flow rate)

| Influence quantity | Range of values of influence quantity | Limits of variation of nominal flow | Reference (sub-clause) | |
|---|---|---|---|---|
| | | | IEC Publ. 761-1 | IEC Publ. 761-2 |
| Time | 1 h to 100 h | ± 10% | 29.1 | |
| Filter presure drop | In accordance with manufacturer's specifications | – 10% | 29.2 | |
| External leakage | Difference between inlet and outlet flow rate less than 5% | Difference between inlet and outlet flow less than 5% | | 15.1 |
| Power supply voltage | From 88% $U_N$ to 110% $U_N$ | ± 5% | 29.3 | |
| Power supply frequency | From 47 Hz to 51 Hz<br>From 57 Hz to 61 Hz for the United States of America and Canada | ± 10% | 29.4 | |

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